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Selection criteria used for the choice of contract type for major highway construction projects

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Abstract

Public highway projects are essential for the economic prosperity and development of each country. This type of construction endeavor is a multidisciplinary effort. The contractor aims at achieving the best profit margin while public authorities as clients, focus on low cost, desired quality and agreement to original schedule. A questionnaire survey investigated Contract Types (CT) against specific selection criteria (SC). The survey was carried out among 42 foreign and Greek experts. Participants rated each contract type against each selection criterion. The survey also correlated data about the participants' profiles and their responses. A database was created and a statistical analysis highlighted the most dominant CT against each criterion.

Contract type, highway projects, project stakeholders, statistical analysis, incentives

1. Introduction

The World Road Association (PIARC) defines procurement as the process whereby an entity purchases works, goods/supplies or services and states that it is common for Road Administrations to consider the procurement of professional or consulting services separately from physical works or contracting services (PIARC 2003). In the context of this paper the Project Procurement System (PPS) is defined as the overall system chosen for the procurement of a major highway project including any contracts required for its design, construction and supervision of construction.

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The procurement process of any major infrastructure project includes the design phase, tender phase and construction phase. In the design phase, the Owner determines the need for the realisation of the project, carries out a feasibility study and completes the required designs either through an internal design team or through outsourcing. In the tender phase, the project budget and tender documents are prepared by the Owner based on the definitive design and a construction tender procedure is carried out according to the relevant legislation and the chosen project procurement system. Finally, the project is constructed according to the contractual documents and supervision is achieved on behalf of the Owner in-house or by outsourcing to a Construction Manager (CM). In addition, the Owner maintains the project throughout its design life (either with in-house resources or out-sourcing). The major participants in the above procedure are the Owner, also known as the Client, the Design Consultant, Contractor and Construction Manager (CM). The PPS chosen defines the number and types of contracts drawn up between the major participants. The number and type of contractual relationships between the major participants are crucial in terms of time, cost and quality achievement of the resulting project.

The most important contractual relationship in terms of cost, is that between the Owner and the Contractor. For this reason, the contractor selection method employed and the chosen Contract Type (CT) which defines the method of payment, play a significant role in ensuring construction costs are within the approved funding limits.

This paper draws conclusions from a survey among highway procurement experts in Greece and abroad (Europe, Australia and USA). The research evaluated a number of contract types against chosen selection criteria. This is a first step towards the development of a comprehensive model to be employed by highway agencies when faced with the choice of Contract Type.

2. Contract type and selection criteria

An extensive literature review of the contract types in use abroad during the past 20 years was carried out. The literature review showed that for public works contract types and in particular regarding the method of compensation, there are numerous reports relating to a) the evaluation of their performance in terms of the final cost, duration and quality of resulting project [ITA 1996, Howard et. al. 1997, Boukendour and Bah 2001, Turner and Simister 2001, Paul and Gutierrez 2005], b) proposals for new contracting methodologies [ITA 1996, Wilmont and Cheng 2003,] c) proposals for new or combinations of award criteria [Ungern-Sternberg 1994, Lambropoulos 2007, Padhi and Mohapatra 2009] or even modifications of the lowest bid criteria [Wang et.al. 2005], d) the evaluation of contractor performance under contracts containing incentives for early completion, lower cost and better performance and their associated risks [Jaraiedi et. al. 1995, Arditi 1997, Bower et. al. 2002, Tang et. Al. 2008, Chan et. al. 2011b], e) proposals of methods for calculating incentives [Jafaari 1996, Al-Subhi Al-Harbi 1998, Arditi and Yasamis 1998, Berends 2000, Shr and Chen 2003, Shr and Chen 2004] and f) motivations for achieving financial incentives by clients and contractors (Rose and Manley 2011, Chan et al. 2011a).

In Greece researchers have been involved in the evaluation of project procurement systems (traditional, design and build, private public partnerships) and contractor selection criteria and procedures (Antoniou and Kalfakakou 2009). A methodology proposed by Lambropoulos (2007) which implements utility theory is currently being included in the new legislation for public works in Greece. This approach defines the requirements of the Client in terms of maximum cost and time for completion of the project tendered and compares it with the contractors' bids which include cost and time discounts. To date there is no proposal for implementation, in the Greek public works scene, of new a CT defining any other method of payment apart from, the Lump sum / fixed price (LSFP), the Unit price method (UPM) or the Cost Plus Percentage Fee (CPPF).

It is therefore essential to consider new contract types for implementation in Greece concerning the procurement of major highway projects. Currently procurement practice on the part of public works' clients is defined in the Greek Public Works Law (L.3669/2008) where the content of the contractors' bids are defined. More specifically, for the majority of major public works' contracts, the detailed construction budget according to the design is made up of a schedule of rates against design quantities for each work item defined in detail in the descriptive price list. The bidder's are asked to offer a discount against these prices, either per item, per group of items or for the entire project. The contractor is compensated for the cost resulting from the quantity of each work item completed multiplied by the offered unit rate plus an additional 18% of the resulting total construction cost to cover overheads and profit. The Greek Public Works law also provides public client's with the option to request a lump sum offer for the completion of part or the total project. This case is normally associated with the design and build procurement method. In addition, Greek Public Works law provides for the enforcement of a penalty in the case of a delay of completion that is due to the fault of the contractor while it also allows for the possibility to provide a bonus for early completion.

Following this review and taking into account the current practice in Greece it was concluded that the contract types to be investigated are Cost Plus Fixed Fee (CPFF), Cost Plus Percentage Fee (CPPF), Cost Plus Incentive Fee (CPIF), Incentive/ Disincentive for Time Reduction (ID/T), Fixed Price Incentive (FPI), Lump Sum / Fixed Price (LSFP), Unit Price Method (UPM). A short description of each CT and their corresponding advantages from the clinet's view point as found in the literature are included in Table 1. As explained previously, the most common CT applied for the major public works projects in Greece is the UPM, while the LSFP contract is used for projects procured with the design and build project procurement system.

Table 1: Contract Types – Definitions and Advantages

Short Description of Contract Type	Advantages
Cost plus fixed fee (CPFF) The client reimburses the contractor for all audited costs & pays a fixed amount for the contractor's services	The resulting project costs is the smallest possible and equal to the actual cost. The cannot earn excessive profits Adverse effects due to potential contractor's loss are a (Ward and Chapman 1994, ITA working group 1995).
Cost plus percentage fee (CPPF) The client reimburses the contractor for all audited costs & pays an additional percentage fee.	
Cost plus incentive fee (CPIF) All justified costs are paid. Final fee depends on actual compared to target cost, delivery and/or performance achievements	Makes risk allocation fairer between Client and Contractor (Tang et. al 2008).
Incentive/ Disincentive for time reduction (ID/T) The contractor is paid in addition to the agreed payment method a bonus (incentive fee) if the project is completed earlier and pays a penalty (disincentive fee) if it is completed after	Reduction in construction time is almost always achieved. Less adversarial relation contractor. Assures good quality of work, as contractor does not risk having to redo (Herbsman et al. 1995, Jaraied et. al. 1993, Tang et. al 2008).
Fixed price incentive (FPI) The contractor is paid his actual costs in addition to an agreed upon fee while he guarantees that the total cost to the owner will not exceed maximum amount	Protects client against cost escalation and provides possibility of benefitting from c Contractor is more efficient to achieve benefits, i.e. achieves value for money. Resu working relationships between the two parties since common goal. Early settlement project account. (Boukendour and Bah 2001, Chan et. al.2011a)
Lump sum / fixed price (LSFP) The client pays a fixed price to the contractor irrespective of the actual cost	Contractor takes all the cost risk. Efficient method for obtaining value for money. I incentive to reduce time in order to reduce overheads. Total cost known from the st burdensome contract administration. (Veld and Peeters 1989, Ward and Chapman Carty 1995, Berends 2000, Turner and Sinister 2001, PIARC 2003, ITA working g
Unit price method (UPM) The contractor commits to fixed prices for pre-specified units of material or work required for the project. Payment is the sum-product of the unit prices and the actual units used	Appropriate when there is uncertainty of scope (Carty 1995, Turner and Sinister 20 2003)

Highway projects are considered by most researchers as linear projects, i.e. they contain repetitive activities, for the purpose of developing methods for scheduling their construction activities (Kallantzis and Lambropoulos 2004a and 2004b and Kallantzis et. Al 2007). Nevertheless, the circumstances under which each highway project is procured in terms of political stability, funding constraints and

construction difficulties (geographical, geological, environmental, archeological and land ownership factors), suggest that highway projects defined in terms of their entire procurement procedures (planning, design, tender and construction phases) cannot be completely considered as repetitive projects. As a result, a statistical analysis of the performance of various projects using various CTs would not lead to representative results. Thus, evaluation criteria most relevant when making the choice of the most appropriate CT were chosen and a relevant questionnaire in order to obtain expert opinions was developed.

The choice of evaluation criteria was based on the results of an extensive literature review. Table 2 depicts the chosen selection criteria to be included in this research, as they were the most frequently cited ones in research papers. The selection criteria that were included in the survey were rated on a scale of 1 to 10 (Table 3). The questionnaire survey was circulated initially to relevant highway procurement experts and 42 responses were obtained to date.

Table 2: Selection criteria as found in the literature

Selection Criteria (freq)	Source
Cost Uncertainty (8)	Veld and Peters 1989, Ward and Chapman 1994, ITA 1996, Berends 2000, Boukendour and Bah 2001, Bower et. al. 2002, Carty 1995, Chan et. al. 2011a
Uncertainty of Scope (6)	Veld and Peters 1989, Ward and Chapman 1994, ITA 1996, Boukendour and Bah 2001, Turner and Simister 2001, Carty 1995
Process Uncertainty (3)	Veld and Peters 1989, ITA 1996, Turner and Simister 2001
Value for Money (3)	Ward and Chapman 1994, ITA 1996, Chan et. al. 2011a.
Criticality of Schedule (4)	Veld and Peters 1989, Jaraiedi et.al. 1995, Herbsman and Glagola 1998, Bower et. al. 2002
Performance Criticality (5)	Veld and Peters 1989, Ward and Chapman 1994, Jaraiedi et.al. 1995, Berends 2000, Bower et. al. 2002
Availability of extra resources (5)	Veld and Peters 1989, ITA 1996, Berends 2000, Turner and Simister 2001, Chan et. al. 2011a.
Contractual Difficulties (3)	ITA 1996, Berends 2000, Turner and Simister 2001
Claims (4)	Jaraiedi et.al. 1995, Herbsman and Glagola 1998, Berends 2000, Chan et. al. 2011a.

Table 3: Explanation of Rating Scale for each Selection Criteria used in Survey

Criteria	Each CT was rated as 10 (on a scale of 1 to 10) if
Cost Uncertainty	It is considered appropriate when it is difficult to estimate the final construction cost and the client wishes to avoid the risk of cost escalation
Uncertainty of Scope	It is appropriate when the technical characteristics of the project are not specifically defined
Process Uncertainty	It is useful in situations where construction methodologies are unknown at start or are expected to be complex.
Value for Money	It provides the most efficient method for obtaining value for money
Criticality of Schedule	It is appropriate when the duration of the contract is critical
Performance Criticality	It provides incentive for excellent quality and avoids cutting corners.
Availability of extra resources	It requires adequate staff in numbers and experience to supervise and/or manage the contract.
Contractual Difficulties	It is simple to implement and does not require specialised calculations
Claims	It reduces the number of claims expected.

3. Description of pool of respondents

The questionnaire was sent to engineers that have professional experience in the management of highway construction projects on behalf of the Awarding authority, the contractor and the funding authority. Table 4 depicts the personal profiles of the respondents. It is seen that 81% of the respondents are of Greek origin while 64% are currently involved in either construction or project management. Over 50% of the respondents have more than 10 years experience in both construction supervision and project management while 79% have less than 10 years experience in the design phase. It is evident that this survey was conducted by addressing engineers with experience in the public sector (76%) while 60% of the respondents have some experience in the private sector, i.e. have worked for contractor's that have constructed major public works projects. Finally, the majority of the 42 respondents have direct

experience in both LSFP contracts and the UPM which are widely employed in Greek public works contracts while nearly a third has experience in the CPPF CT.

Table 4: Personal profiles of survey respondents

Category	Respondents		Category	Respondents		Category	Respondents	
	Number	%		Number	%		Number	%
Current Occcupational Field			**Years of Private Sector Experience**			**Years of Project Management Experience**		
Constuction Management	16	38%	None	17	40%	None	12	29%
Project Management	11	26%	Below 9 years	12	29%	Below 9 years	8	19%
Design – Research - Funding	4	10%	10-19 years	8	19%	10-19 years	14	33%
Construction - Freelance	11	26%	over 20 years	5	12%	over 20 years	8	19%
Years of Design Experience			**Direct Experience per Contract Type**			**Origin**		
None	21	50%	CPFF	8	19%	Greece	34	81%
Below 9 years	12	29%	CPPF	13	31%	Abroad	8	19%
10-19 years	4	10%	CPIF	4	10%	**Years of Public Sector Experience**		
over 20 years	5	12%	ID/T	8	19%	None	10	24%
Years of Construction Supervision Experience			FPI	4	10%	Below 9 years	9	21%
None	10	24%	LS/FP	26	62%	10-19 years	8	19%
Below 9 years	10	24%	UPM	34	81%	over 20 years	15	36%
10-19 years	15	36%						
over 20 years	7	17%						

4. Survey results

The average rating for each CT against each criterion for selected Greek experts with more than 10 and 20 years experience in public works and foreign experts are shown in table 5. Fig. 1 depicts the average ratings (av.) from those respondents with direct experience in each CT. It is assumed that the results of this initial survey provide fairly safe conclusions if the standard deviation (st.dev.) is less than 2. The most dominant CTs against each criterion as depicted in table 4 are discussed as follows:

Criterion 1: Cost Uncertainty. Overall, the CTs that are most appropriate when it is difficult to estimate the final construction cost and the client wishes to avoid the risk of cost escalation are FPI (av.=7.70) and LSFP (av. =7.82). The third most effective CT against this criterion as rated by Greek experts is the UPM (av. =6.15), while foreign respondents believe that the third best is CPIF (av. = 5.80). Fig. 2 shows that the 8 respondents directly experienced in the CPFF rate it as the third best against this criterion (av. = 7.00).

Criterion 2: Uncertainty of Scope. No CT stands out as especially appropriate when the technical characteristics of the project are not specifically defined. Nevertheless, it is interesting to note that respondents from abroad give the greatest rating of 6.80 to CPIF CT for this criterion.

Criterion 3: Process Uncertainty. The overall results show that no CT stands out as especially useful in situations where construction methodologies are unknown at start or are expected to be complex. Nevertheless, respondents from abroad seemed to agree once again that the CPIF CT is the best choice against this criterion by rating it with 7.20. Greek experts with greater than 20 years experience in Public works gave an even greater rating of 7.33 to the LSFP. Finally, the 24 respondents with direct experience in the LSFP CT believe it provides the best match to this criterion.

Criterion 4: Value for Money. The CT that provides the most efficient method for obtaining value for money is the LSFP (av.=7.03). Again, according to the experience of Greek experts, the most efficient CT by far for achieving value for money is the UPM (av.=7.69) and their foreign counterparts believe that the CPIF (av.=7.00) CT meets this criterion best. Respondents with direct experience in each contract type agree with the aforementioned results and in addition the 8 respondents with direct experience with the CPFF also rate it highly in terms of this criterion (av.=6.50).

Criterion 5: Criticality of Schedule The results show that the CT most appropriate when the duration of the contract is critical is obviously the ID/T (av.=8.23).

Criterion 6: Performance Criticality. The results show that the CPIF CT is perceived both by Greek experts and respondents from abroad to be slightly better than the others at providing incentive for excellent quality and preventing contractors from cutting corners. According to the 30 respondents with direct experience in the UPM, it is the CT that suits the criterion of performance criticality best (av.=6.8).

Criterion 7: Availability of extra resources. There seems to be no CT type that stands out as requiring more staff in numbers and experience to supervise and/or manage the contract. The lowest overall rating of 5.53 was awarded to the LSFP which is what is expected in theory. In addition, all three methods based on the requirement for the Client to reimburse the contractor for all auditable costs (CPFF, CPPF, CPIF) as well as the UPM which requires that the Client measures accurately the quantities of the work items completed received a slightly higher rating overall .

Criterion 8: Contractual Difficulties. The results show that three CT incorporating incentives, i.e. CPIF, FPI and ID/T, tend to be rated as more complicated to implement and hence received the lowest overall ratings. It is interesting to note that the Greek experts rated the two most familiar CTs in Greece, i.e. the LSFP (av.=7.18) and the UPM (av.=6.28) as the CTs that are simplest to implement and do not require specialized calculations. Finally, the average ratings by respondents with direct experience in each CT designated that the simplest to implement CT is the FPI (av.=7.51).

Criterion 9: Claims. The CTs CPFF (av.=6.50), CPPF (av.=5.81) and LSFP (av.=6.82) are considered by the respondents to be slighter better at reducing the number of claims expected.

Table 5: Average and standard deviation of ratings of each Contract Type against each Criterion

Selection Criteria		CPFF		CPPF		CPIF		ID/T		FPI		LSFP		UPM	
Contract Type Rating per		Av.	St. Dev.	Av.	St. Dev.	Av.	St. Dev.	Av.	St. Dev.	Av.	St. Dev.	Av.	St. Dev.	Av.	St. Dev.
Cost uncertainty (C1)	All	5,45	2,72	4,72	2,81	5,00	2,18	4,57	2,12	7,70	2,02	7,82	2,40	5,53	2,43
	GR	5,29	2,76	4,50	2,76	5,20	2,62	4,79	2,52	7,29	2,49	7,71	2,99	6,15	2,12
	Abroad	3,60	1,52	4,20	2,28	5,80	2,28	4,40	1,82	7,00	0,82	7,38	1,06	5,25	1,98
Uncertainty of scope (C2)	All	5,73	2,61	6,22	2,55	6,07	2,12	5,07	2,31	4,96	2,59	5,24	3,08	5,47	3,08
	GR	6,47	2,47	6,56	2,48	6,31	2,24	5,71	2,61	4,57	3,06	5,33	2,97	5,92	3,09
	Abroad	5,40	2,19	5,60	2,88	6,80	1,30	4,40	1,82	5,50	1,73	4,13	2,53	4,50	2,78
Process uncertainty (C3)	All	5,17	2,65	5,68	2,56	6,54	1,84	5,63	1,96	5,67	2,51	6,19	2,68	4,70	2,73
	GR	4,33	3,04	4,78	2,91	6,67	2,24	6,75	2,55	6,38	3,66	7,33	2,50	4,43	2,64
	Abroad	5,00	2,24	5,80	2,68	7,20	1,30	4,40	2,07	5,50	1,73	5,63	2,26	4,25	2,49
Value for money (C4)	All	5,40	2,08	4,91	2,31	5,52	2,03	5,37	2,77	6,50	2,12	7,03	2,24	6,76	2,65
	GR	5,47	2,23	5,27	2,55	5,73	2,34	5,73	3,39	6,43	1,83	6,47	2,20	7,69	2,14
	Abroad	4,80	1,64	4,80	1,92	7,00	1,00	5,40	1,67	6,75	0,96	6,25	1,98	6,50	1,93
Criticality of schedule (C5)	All	5,00	1,93	4,81	1,91	6,53	1,94	8,23	2,14	5,32	1,89	5,00	2,12	5,37	2,39
	GR	4,93	1,79	5,07	1,79	6,94	1,98	8,07	2,37	4,86	2,11	4,60	2,38	4,54	1,81
	Abroad	5,20	1,64	5,00	1,87	6,80	1,10	9,20	0,84	6,50	1,29	5,38	2,07	5,25	1,04
Performance criticality (C6)	All	4,90	2,73	5,75	2,85	7,52	2,21	5,83	2,27	5,61	2,04	4,64	2,38	6,49	2,25
	GR	5,87	2,61	6,33	2,50	7,53	2,07	6,29	2,05	6,14	2,07	4,80	2,27	6,15	1,68
	Abroad	5,60	3,05	7,00	2,92	7,00	2,65	5,40	2,07	5,75	2,22	4,38	1,60	5,63	2,13
Availability of extra resources (C7)	All	6,27	2,55	6,47	2,36	6,83	2,67	6,52	2,34	5,64	2,66	5,53	2,26	6,89	2,16
	GR	7,33	2,06	7,27	1,87	7,40	2,29	6,79	2,64	6,00	2,45	6,69	2,06	6,86	2,07
	Abroad	6,20	2,59	5,40	1,82	5,60	2,07	5,40	2,30	6,50	1,29	5,63	2,20	5,75	2,19
Contractual difficulties (C8)	All	6,52	2,28	6,06	2,08	3,86	2,13	5,03	2,15	5,75	1,48	7,18	2,71	6,28	2,57
	GR	6,07	2,28	5,88	2,09	3,93	1,94	5,00	2,18	5,86	1,03	7,20	2,65	7,36	2,10
	Abroad	4,60	1,67	5,00	1,73	4,00	1,22	6,00	1,41	6,50	1,73	6,50	2,78	6,38	2,56
Claims (C9)	All	6,50	2,75	5,81	2,60	4,69	2,45	4,97	2,08	5,57	1,93	6,82	2,90	5,46	2,43
	GR	6,33	2,74	6,27	2,60	5,27	2,69	5,00	2,08	5,71	2,20	6,13	3,01	5,15	2,19
	Abroad	6,60	3,05	6,20	2,77	5,40	2,79	4,40	1,95	6,00	2,00	6,00	2,65	6,13	1,36

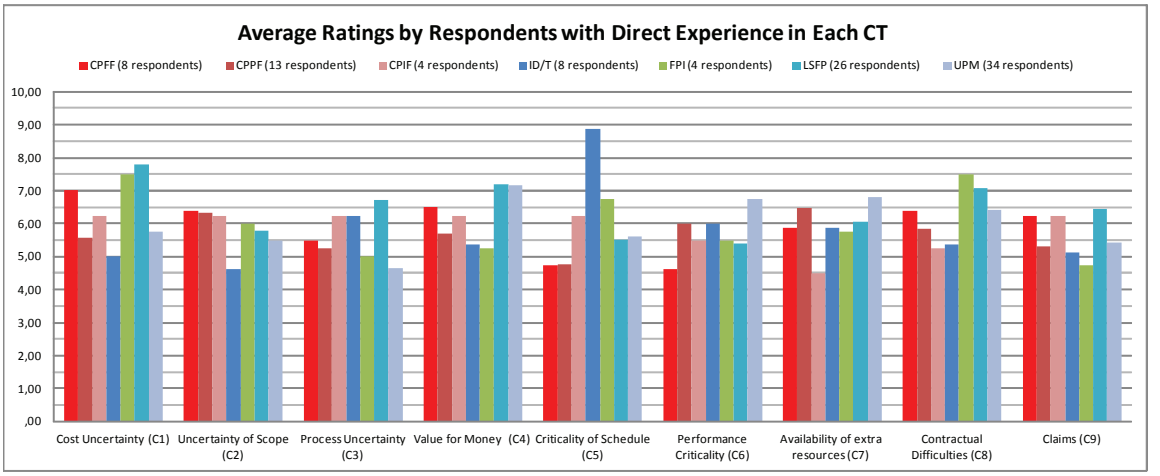

Fig. 1. Average ratings of each CT against each criterion by respondents with direct experience in each CT.

5. Correlations between participants' profiles and responses

The study identified correlations among participants' profiles and their responses concerning the suitability of each CT against each criterion. The SPSS 18 PASW application was used to produce the statistical results. The analysis employed was the "descriptive analysis" and the method chosen was "Chi – square analysis" which identified correlations between the participants' profiles and their responses. Following the above described correlation analysis the following conclusions can be drawn:

- Those currently employed in construction management (managing services) tend to rate the CT Unit price method (UPM) with 10 against the criteria Cost uncertainty. In other words they tend to believe that the UPM is appropriate when it is difficult to estimate the final construction cost and the client wishes to avoid the risk of cost escalation while those employed in project management on behalf of the client are less confident as they tend to rate the UPM against the same Criterion with 5. It is interesting to note that those employed in design, research and funding services have a totally opposite opinion as they tend to rate the same CT against the same Criterion with 1 while the contractors tend to rate this CT against the same Criterion with both 3 and 7.
- A fairly borderline result (Asymp. Sig=0,054) is that designers, researchers etc. and contractors tend to rate the UPM with 1 and 3 respectively against the Value for Money Criterion, i.e. they tend to believe that the UPM does not provide the most efficient method for obtaining value for money.
- Those currently employed either in construction management (managing service) and project management (on behalf of the client) tend to rate the CT CPIF with 4 and 5 respectively against the Contractual Difficulties Criterion, ie they tend to believe that it is average in terms of its simplicity to implement.
- Those respondents with 10-19 years design experience tend to rate the CT Lump sum / fixed price (LSFP) with 8 against the Uncertainty of Scope Criterion which means that they believe it is an approriate CT when the technical characteristics of the project are not specifically defined. On the other hand, more experienced designers seem to be less confident providing a rating of only 3.

6. Conclusions and Further Research

The initial results highlighted the most dominant CTs against each criterion. The analysis concludes that no single CT stands out as being considered the most appropriate, when considering all selection criteria,

for implementation in Greek highway construction projects. Research focused on experts in the Greek Public Sector with more than 10 years experience. When comparing their opinions with the overall results, the most significant differences are that a) they rate the UPM, with which they are most familiar with, as the best method in terms of achieving the best value for money and being the easiest to implement with the least contractual difficulties, while the overall results conclude that the LSFP is best and b) they rate the LSFP CT as the most efficient when the construction methodologies are unknown at start or are expected to be complex while the overall results show that the CPIF achieves this criteria best. Finally, when examining the results of the average ratings of those respondents with direct experience in each CT the most significant outcome is that those with direct experience in the LSFP method believe it to be the most appropriate when it is difficult to estimate the final construction cost, construction methodologies are unknown at start or are expected to be complex, for obtaining value for money and at reducing the number of claims expected. In addition, those with direct experience in the UPM consider it to be better, than the rest, at providing incentive for excellent quality and preventing contractors from cutting corners, but requires more staff in numbers and experience to supervise and/or manage the contract.

The correlation analysis carried out between the participants' profiles and their ratings of each CT highlights that responses are strongly affected by the knowledge and experience of the specific CT. Participants tend to support the CTs they have been implementing in their projects. It also becomes apparent that the evaluation of the CT performance against each criterion is heavily dependent on the particular professional involvement of each participant and his / her own personal perspective on the matter. The participants should be grouped and examined by taking into account the legislation regarding project contracts in the country they are employed in.

Future work will focus on the collection of additional responses and developing a comprehensive model to be employed by highway agencies when faced with selecting the appropriate CT Type most compatible with the specific project characteristics, the Owner's needs and the market situation. The next step in this research endeavor is to apply the multi-attribute utility analysis by which the utility values (U) of each CT against each criterion will be calculated from a rigorous statistical analysis of the survey results and the corresponding weights for representing the importance of each criteria for a specific highway project will be derived from a chosen selection panel of experts.

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